Pantheon Report

Generated at 2018-09-03 14:13:43 (UTC).

Data path: GCE Tokyo on `ens4` (*remote*) →GCE Sydney on `ens4` (*local*).

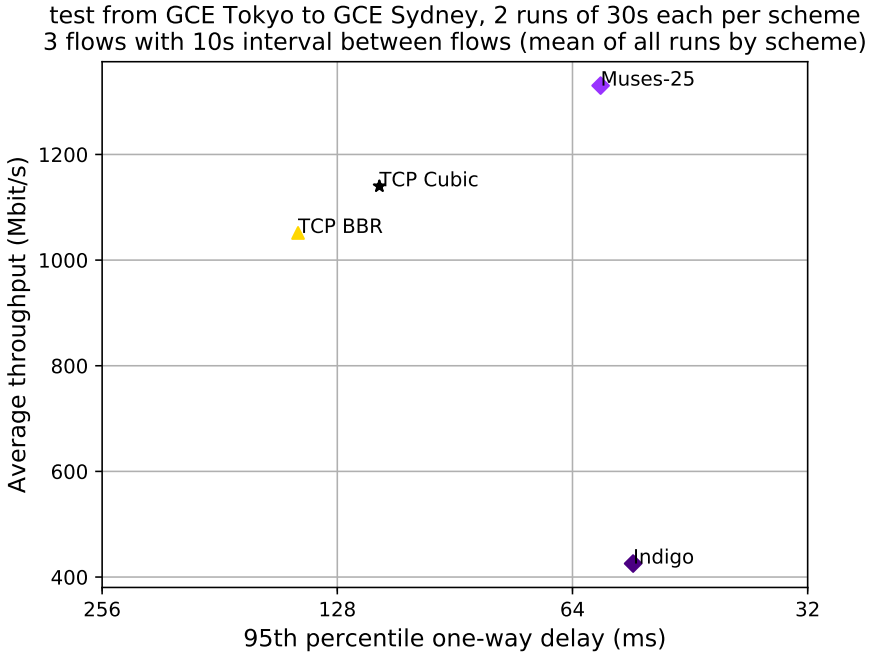
Repeated the test of 4 congestion control schemes twice.

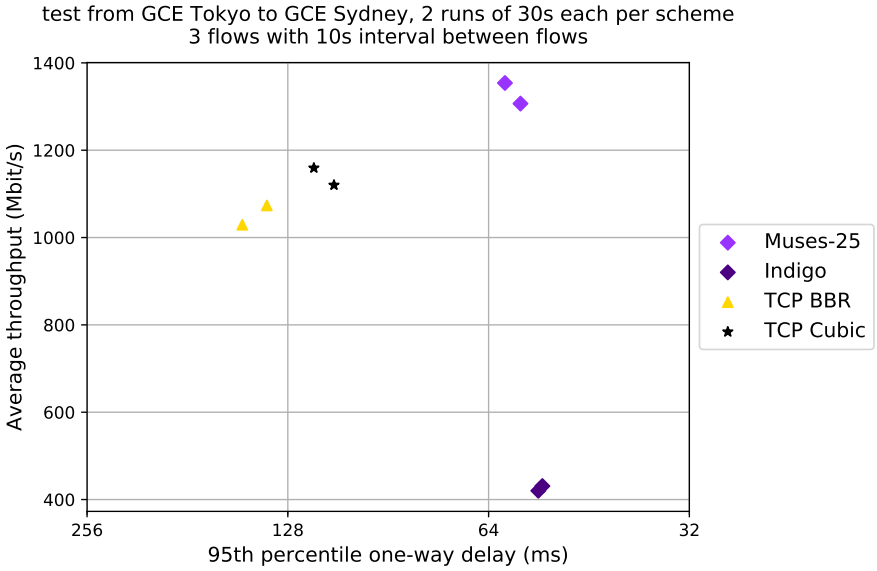
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.

NTP offsets were measured against `time.google.com` and have been applied to correct the timestamps in logs.

```
System info:
Linux 4.15.0-1018-gcp
net.core.default_qdisc = fq
net.core.rmem_default = 16777216
net.core.rmem_max = 536870912
net.core.wmem_default = 16777216
net.core.wmem_max = 536870912
net.ipv4.tcp_rmem = 4096 16777216 536870912
net.ipv4.tcp_wmem = 4096 16777216 536870912
net.ipv4.tcp_mem = 536870912 536870912 536870912
```

```
Git summary:
branch: muses @ f309f5459e2c5237279a184e52ece7a2b47ef1c9
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/muses @ b8d5019b83a3a678804d830fcfe1da7b3a63421b
third_party/pantheon-tunnel @ cbfce6db5ff5740dafe1771f813cd646339e1952
third_party/pcc @ 1afc958fa0d66d18b623c091a55fec872b4981e1
 M receiver/src/buffer.h
 M receiver/src/core.cpp
 M sender/src/buffer.h
 M sender/src/core.cpp
third_party/pcc-experimental @ cd43e34e3f5f5613e8acd08fab92c4eb24f974ab
third_party/proto-quic @ 77961f1a82733a86b42f1bc8143ebc978f3cff42
third_party/scream-reproduce @ f099118d1421aa3131bf11ff1964974e1da3bdb2
 M src/ScreamClient
 M src/ScreamServer
third_party/sprout @ 366e35c6178b01e31d4a46ad18c74f9415f19a26
third_party/verus @ d4b447ea74c6c60a261149af2629562939f9a494
 M src/verus.hpp
 M tools/plot.py
third_party/vivace @ 2baf86211435ae071a32f96b7d8c504587f5d7f4
third_party/webrtc @ 3f0cc2a9061a41b6f9dde4735770d143a1fa2851
```


test from GCE Tokyo to GCE Sydney, 2 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)
Muses-25
TCP Cubic
TCP BBR
Indigo
Average throughput (Mbit/s)
1200
1000
800
600
400
256
128
64
32
95th percentile one-way delay (ms)


test from GCE Tokyo to GCE Sydney, 2 runs of 30s each per scheme
3 flows with 10s interval between flows
Average throughput (Mbit/s)
1400
1200
1000
800
600
400
256
128
64
32
95th percentile one-way delay (ms)
Muses-25
Indigo
TCP BBR
TCP Cubic

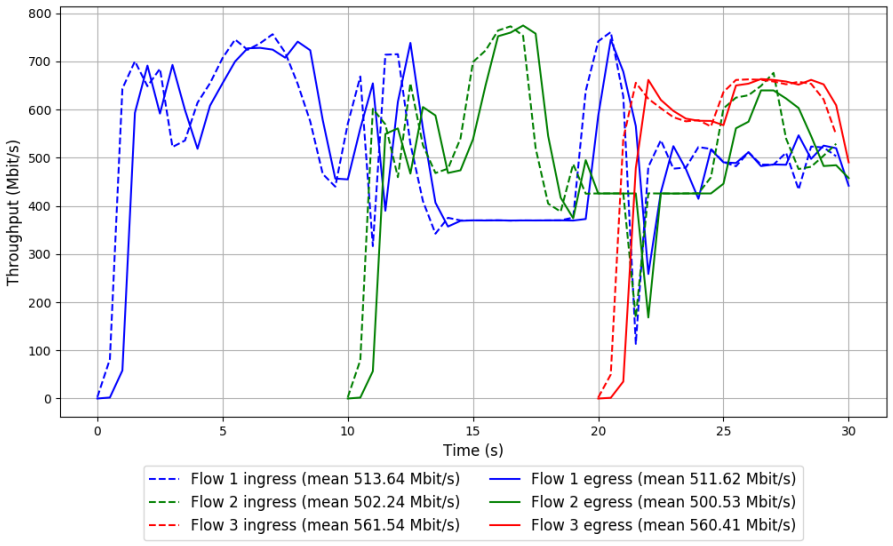
scheme	# runs	mean avg tput (Mbit/s)			mean 95th-%ile delay (ms)			mean loss rate (%)		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
TCP BBR	2	536.62	514.01	526.58	150.64	153.56	99.66	0.84	1.04	1.16
TCP Cubic	2	614.73	540.22	502.34	114.88	107.28	94.48	0.39	0.58	1.35
Indigo	2	226.50	209.58	185.35	50.74	52.63	54.39	0.35	0.56	1.25
Muses-25	2	740.28	624.00	537.94	58.76	58.44	61.86	0.29	0.55	1.18

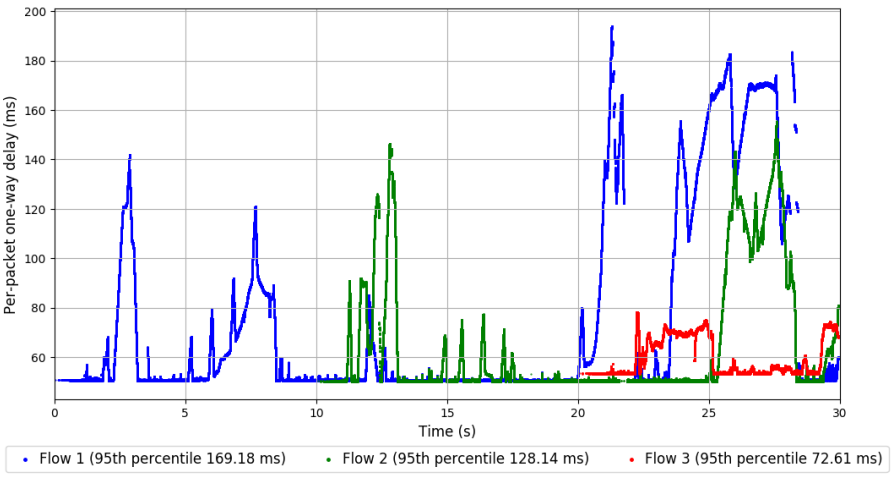
```
Run 1: Statistics of TCP BBR

Start at: 2018-09-03 13:43:27
End at: 2018-09-03 13:43:57
Local clock offset: 0.074 ms
Remote clock offset: -0.047 ms

# Below is generated by plot.py at 2018-09-03 14:12:07
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1029.33 Mbit/s
95th percentile per-packet one-way delay: 149.785 ms
Loss rate: 0.86%
-- Flow 1:
Average throughput: 511.62 Mbit/s
95th percentile per-packet one-way delay: 169.175 ms
Loss rate: 0.73%
-- Flow 2:
Average throughput: 500.53 Mbit/s
95th percentile per-packet one-way delay: 128.139 ms
Loss rate: 0.84%
-- Flow 3:
Average throughput: 560.41 Mbit/s
95th percentile per-packet one-way delay: 72.613 ms
Loss rate: 1.25%
```

Run 1: Report of TCP BBR — Data Link



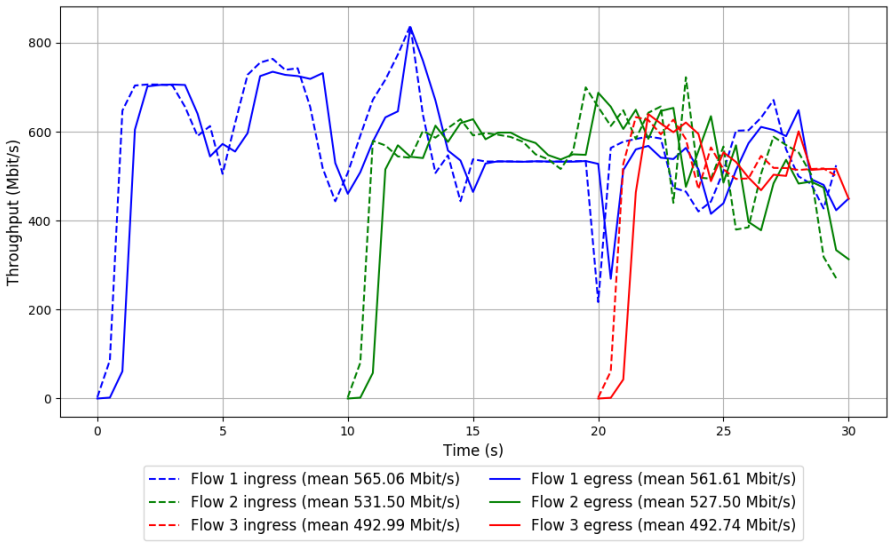


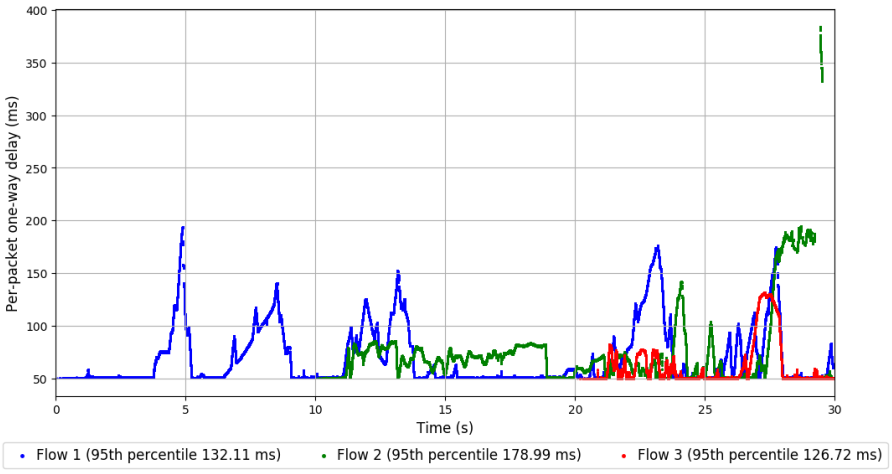
```
Run 2: Statistics of TCP BBR

Start at: 2018-09-03 13:51:18
End at: 2018-09-03 13:51:48
Local clock offset: -0.053 ms
Remote clock offset: -0.274 ms

# Below is generated by plot.py at 2018-09-03 14:12:26
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1073.56 Mbit/s
95th percentile per-packet one-way delay: 137.616 ms
Loss rate: 1.06%
-- Flow 1:
Average throughput: 561.61 Mbit/s
95th percentile per-packet one-way delay: 132.110 ms
Loss rate: 0.95%
-- Flow 2:
Average throughput: 527.50 Mbit/s
95th percentile per-packet one-way delay: 178.988 ms
Loss rate: 1.25%
-- Flow 3:
Average throughput: 492.74 Mbit/s
95th percentile per-packet one-way delay: 126.717 ms
Loss rate: 1.06%
```

Run 2: Report of TCP BBR — Data Link



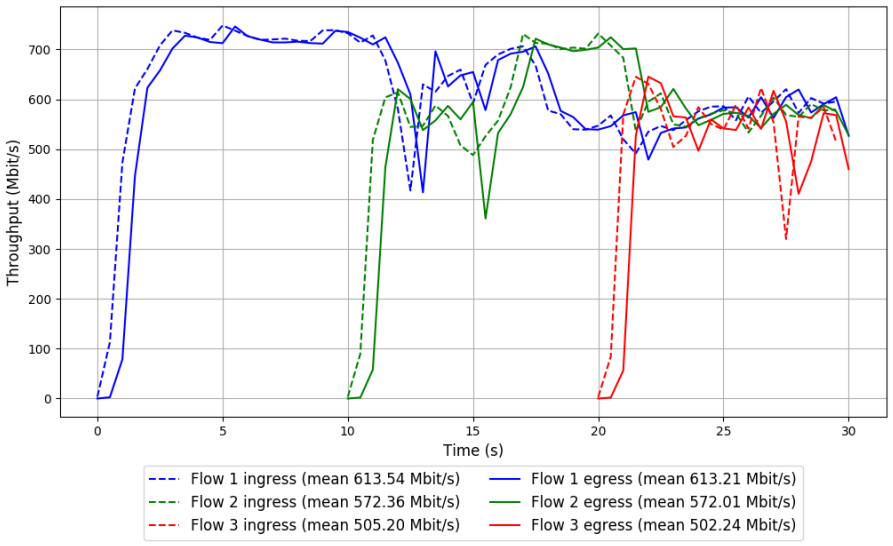


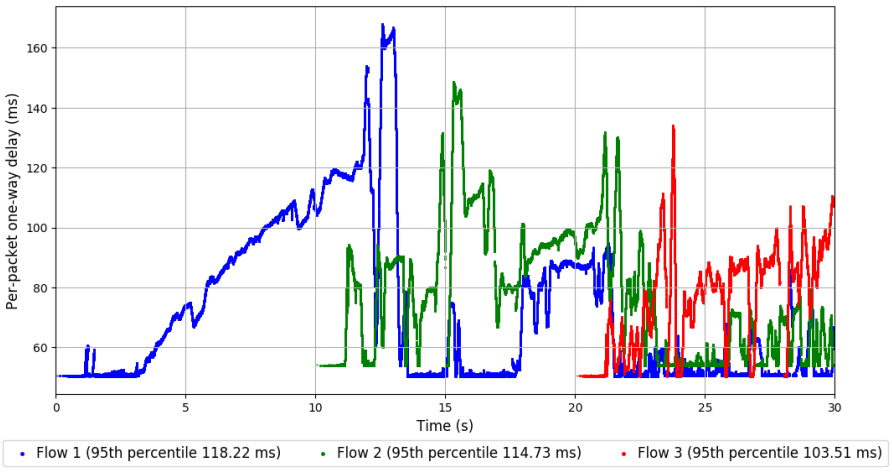
```
Run 1: Statistics of TCP Cubic

Start at: 2018-09-03 13:45:27
End at: 2018-09-03 13:45:57
Local clock offset: 0.066 ms
Remote clock offset: -0.274 ms

# Below is generated by plot.py at 2018-09-03 14:12:51
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1159.37 Mbit/s
95th percentile per-packet one-way delay: 116.995 ms
Loss rate: 0.63%
-- Flow 1:
Average throughput: 613.21 Mbit/s
95th percentile per-packet one-way delay: 118.216 ms
Loss rate: 0.39%
-- Flow 2:
Average throughput: 572.01 Mbit/s
95th percentile per-packet one-way delay: 114.731 ms
Loss rate: 0.58%
-- Flow 3:
Average throughput: 502.24 Mbit/s
95th percentile per-packet one-way delay: 103.510 ms
Loss rate: 1.59%
```

Run 1: Report of TCP Cubic — Data Link



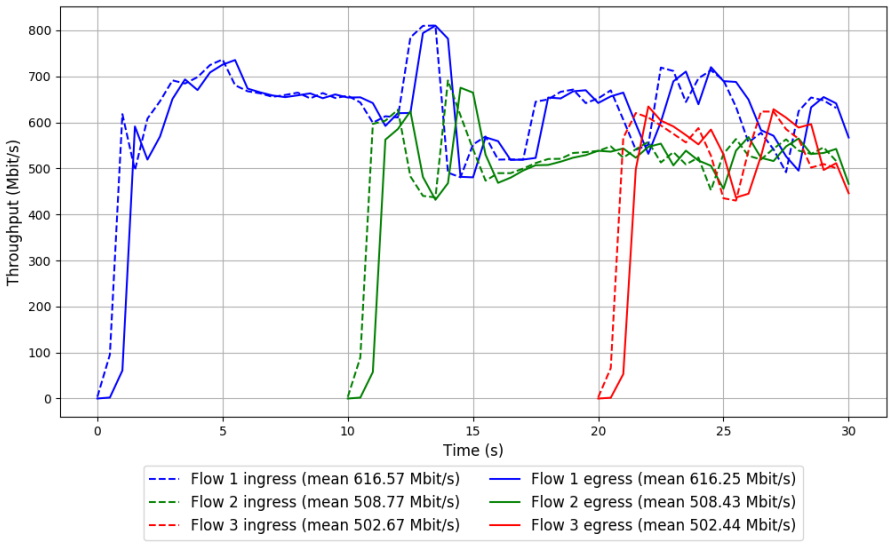


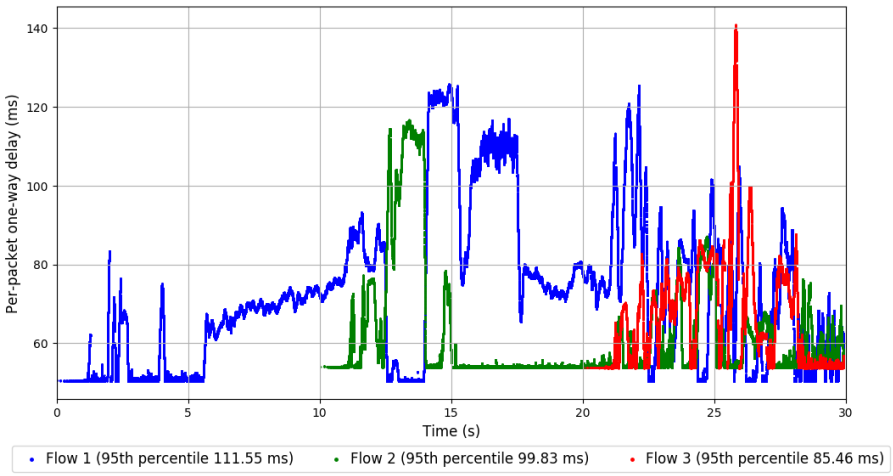
```
Run 2: Statistics of TCP Cubic

Start at: 2018-09-03 13:53:22
End at: 2018-09-03 13:53:52
Local clock offset: 0.113 ms
Remote clock offset: -0.197 ms

# Below is generated by plot.py at 2018-09-03 14:12:51
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1120.18 Mbit/s
95th percentile per-packet one-way delay: 109.145 ms
Loss rate: 0.55%
-- Flow 1:
Average throughput: 616.25 Mbit/s
95th percentile per-packet one-way delay: 111.546 ms
Loss rate: 0.39%
-- Flow 2:
Average throughput: 508.43 Mbit/s
95th percentile per-packet one-way delay: 99.827 ms
Loss rate: 0.58%
-- Flow 3:
Average throughput: 502.44 Mbit/s
95th percentile per-packet one-way delay: 85.457 ms
Loss rate: 1.10%
```

Run 2: Report of TCP Cubic — Data Link



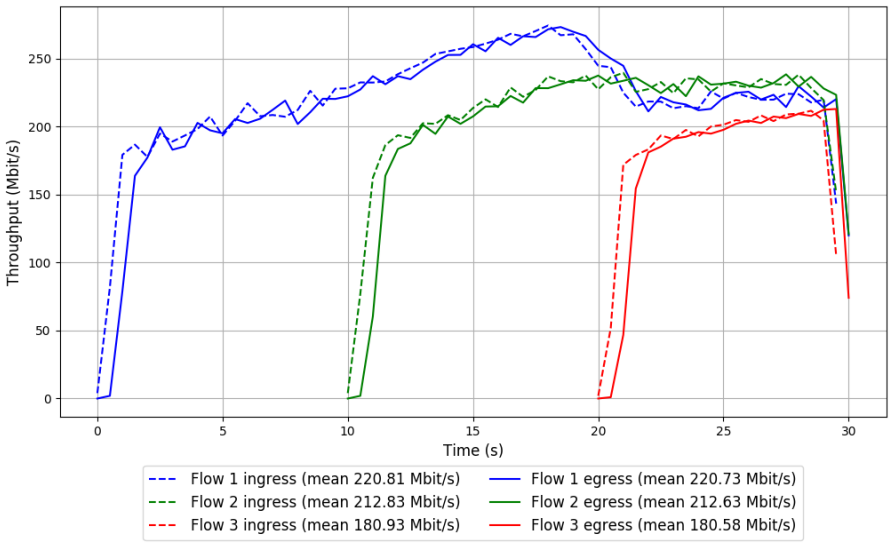


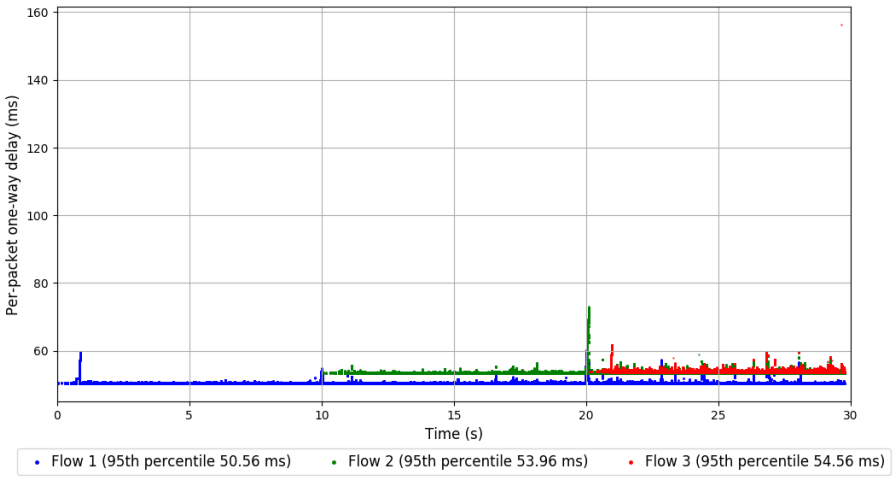
```
Run 1: Statistics of Indigo

Start at: 2018-09-03 13:39:39
End at: 2018-09-03 13:40:09
Local clock offset: 0.085 ms
Remote clock offset: -0.173 ms

# Below is generated by plot.py at 2018-09-03 14:12:51
# Datalink statistics
-- Total of 3 flows:
Average throughput: 420.18 Mbit/s
95th percentile per-packet one-way delay: 53.906 ms
Loss rate: 0.57%
-- Flow 1:
Average throughput: 220.73 Mbit/s
95th percentile per-packet one-way delay: 50.557 ms
Loss rate: 0.37%
-- Flow 2:
Average throughput: 212.63 Mbit/s
95th percentile per-packet one-way delay: 53.962 ms
Loss rate: 0.61%
-- Flow 3:
Average throughput: 180.58 Mbit/s
95th percentile per-packet one-way delay: 54.558 ms
Loss rate: 1.26%
```

Run 1: Report of Indigo — Data Link



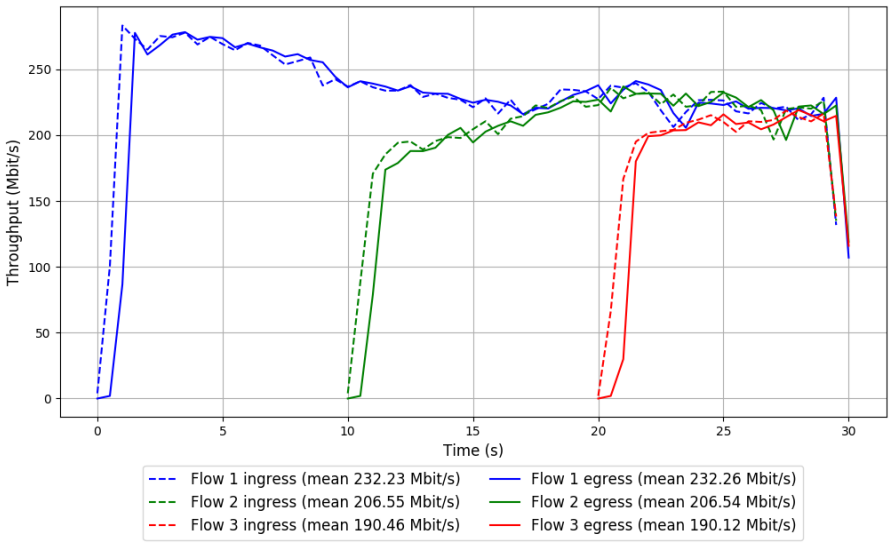


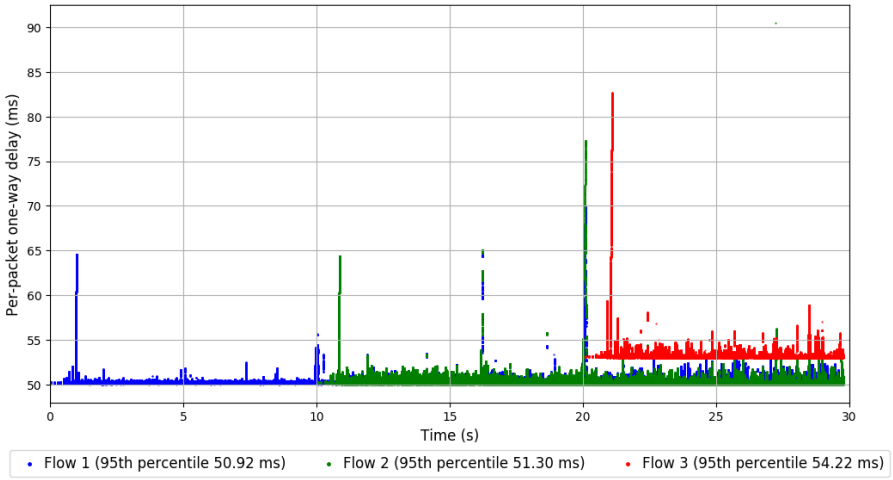
```
Run 2: Statistics of Indigo

Start at: 2018-09-03 13:47:31
End at: 2018-09-03 13:48:01
Local clock offset: -0.093 ms
Remote clock offset: -0.047 ms

# Below is generated by plot.py at 2018-09-03 14:12:51
# Datalink statistics
-- Total of 3 flows:
Average throughput: 430.87 Mbit/s
95th percentile per-packet one-way delay: 53.151 ms
Loss rate: 0.52%
-- Flow 1:
Average throughput: 232.26 Mbit/s
95th percentile per-packet one-way delay: 50.921 ms
Loss rate: 0.33%
-- Flow 2:
Average throughput: 206.54 Mbit/s
95th percentile per-packet one-way delay: 51.300 ms
Loss rate: 0.52%
-- Flow 3:
Average throughput: 190.12 Mbit/s
95th percentile per-packet one-way delay: 54.222 ms
Loss rate: 1.23%
```

Run 2: Report of Indigo — Data Link



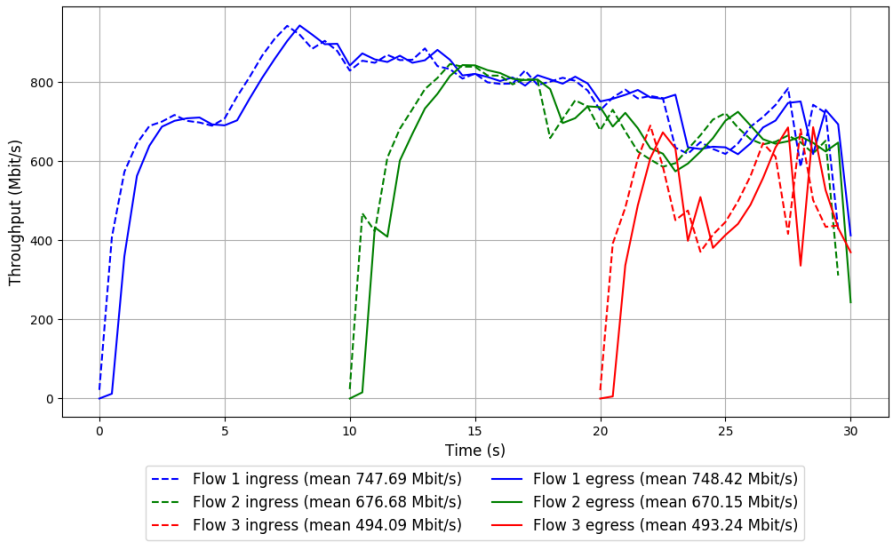


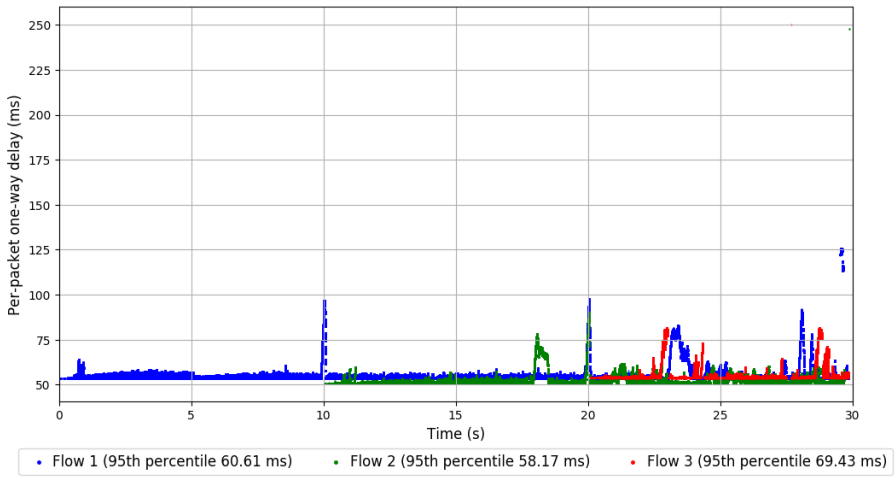
```
Run 1: Statistics of Muses-25

Start at: 2018-09-03 13:41:25
End at: 2018-09-03 13:41:55
Local clock offset: 0.094 ms
Remote clock offset: -0.18 ms

# Below is generated by plot.py at 2018-09-03 14:13:41
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1353.95 Mbit/s
95th percentile per-packet one-way delay: 60.486 ms
Loss rate: 0.49%
-- Flow 1:
Average throughput: 748.42 Mbit/s
95th percentile per-packet one-way delay: 60.612 ms
Loss rate: 0.30%
-- Flow 2:
Average throughput: 670.15 Mbit/s
95th percentile per-packet one-way delay: 58.170 ms
Loss rate: 0.52%
-- Flow 3:
Average throughput: 493.24 Mbit/s
95th percentile per-packet one-way delay: 69.432 ms
Loss rate: 1.24%
```

Run 1: Report of Muses-25 — Data Link





```
Run 2: Statistics of Muses-25

Start at: 2018-09-03 13:49:18
End at: 2018-09-03 13:49:48
Local clock offset: -0.239 ms
Remote clock offset: -0.126 ms

# Below is generated by plot.py at 2018-09-03 14:13:41
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1306.74 Mbit/s
95th percentile per-packet one-way delay: 57.331 ms
Loss rate: 0.50%
-- Flow 1:
Average throughput: 732.14 Mbit/s
95th percentile per-packet one-way delay: 56.904 ms
Loss rate: 0.29%
-- Flow 2:
Average throughput: 577.84 Mbit/s
95th percentile per-packet one-way delay: 58.706 ms
Loss rate: 0.59%
-- Flow 3:
Average throughput: 582.64 Mbit/s
95th percentile per-packet one-way delay: 54.283 ms
Loss rate: 1.12%
```

Run 2: Report of Muses-25 — Data Link